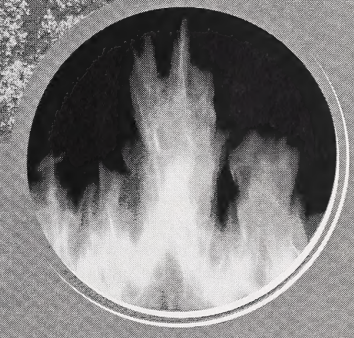
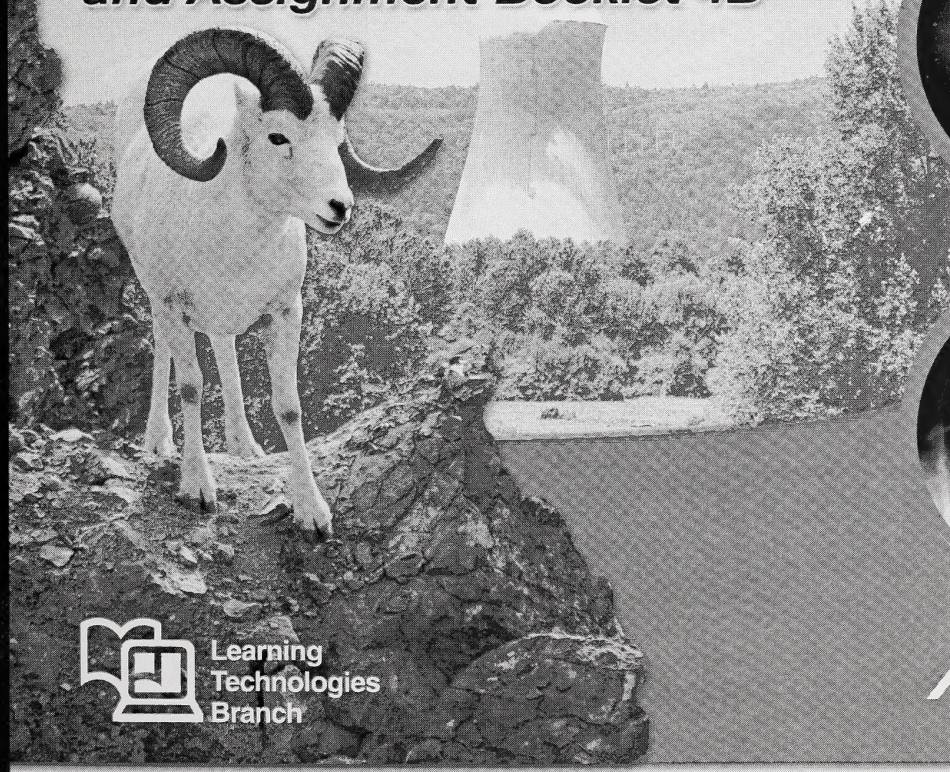
SCIENCE 9

Module 4

Electrical Principles and Technologies

Home Instructor's Guide and Assignment Booklet 4B





Learning Technologies Branch

Alberta LEARNING

Science 9
Module 4: Electrical Principles and Technologies
Home Instructor's Guide and Assignment Booklet 4B
Learning Technologies Branch
ISBN 0-7741-2594-2

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The Learning Technologies Branch acknowledges with appreciation the Alberta Distance Learning Centre and Pembina Hills Regional Division No. 7 for their review of this Home Instructor's Guide and Assignment Booklet.

This document is intended for	
Students	✓
Teachers	✓
Administrators	
Home Instructors	✓
General Public	
Other	

You may find the following Internet sites useful:

- Alberta Learning, **http://www.learning.gov.ab.ca**
- Learning Technologies Branch, **http://www.learning.gov.ab.ca/ltb**
- Learning Resources Centre, **http://www.lrc.learning.gov.ab.ca**

The use of the Internet is optional. Exploring the electronic information superhighway can be educational and entertaining. However, be aware that these computer networks are not censored. Students may unintentionally or purposely find articles on the Internet that may be offensive or inappropriate. As well, the sources of information are not always cited and the content may not be accurate. Therefore, students may wish to confirm facts with a second source.

Section 3: Electricity Production, Distribution, and Use

This section is about the large-scale production of electricity and its use. The student studies electromagnetic principles—the principles that make electromagnets, electric motors, and generators possible. The student calculates the power and the cost of electric energy. The student expresses energy efficiency as a percentage. The student looks at the generation of electric energy and learns how electric power is distributed to users. The student assesses environmental impacts and explores alternative sources of energy.

The following materials will be needed to complete this section.

Section 3: Lesson 1

- 60 cm of enamel coated magnet wire
- two large paper clips
- a fresh D-cell
- a wide rubber band
- one disposable cup
- a rectangular or round ceramic magnet (about 1 cm by 3 cm)
- tape
- fine sandpaper or steel wool
- a broom handle
- a 5 m insulated 26 gauge copper wire
- a cardboard tube
- a multimeter
- a bar magnet

Section 3: Lesson 2

No extra materials are needed for this lesson.

Section 3: Lesson 3

No extra materials are needed for this lesson.

Section 3: Lesson 4

No extra materials are needed for this lesson.

Suggested Answers

Section 3: Lesson 4

Textbook questions 1, 2, 8, and 9 of "Wrap-up: Topics 6 to 8," page 343:

1. The terms in column B line up with the terms in column A in this order:

   - electric generator
   - dynamo
   - fuse
   - scrubbers
   - watt
   - stator
   - transformers
   - circuit breaker
   - thermal pollution
   - ground wire

   Note: The order is down the first column and then down the second column.

2. For alternating current (AC), the electrons flow back and forth in the conductor. For direct current (DC), the electrons flow only in one direction. AC is produced by AC generators, with no split-ring commutator. Meanwhile, DC is produced by cells and batteries, photovoltaic cells, and DC generators—a split-ring commutator.

8. A kilowatt hour is an energy unit used to measure electric energy consumption that is equal to the energy used when 1000 W of power are used for 1 h. The formula for energy is $E = Pt$, where E is in $kW \bullet h$, power, P, is in kW, and t is time in hours.

   Note how $1\ kW \bullet h$ can be converted to joules of energy. Again use the formula $E = Pt$.

   But use watts for power and seconds for time.

   $1\ kW \bullet h = 1000\ W \bullet h \qquad 1\ W = 1\ J/s \qquad 1\ h = 3600\ s$

   $1\ kW \bullet h = 1000 \times 3600\ s = 3\ 600\ 000\ J = 3.6\ MJ$

9. A short circuit occurs when an electric current takes an alternate path from the intended one. The current may take an alternate route when a hot wire touches a neutral or ground wire in error. This contact could be due to frayed or loose wires that are touching each other. The current may also take an alternate route when a hot wire gets wet or a person standing in water touches a hot wire.

Module Review

Textbook questions 10, 13, 16, 28, 32, 36, and 38, pages 349 to 351:

10. The stations and substations either increase or decrease the voltage of the electrical energy being distributed. Step-up and step-down transformers are used to do this. Transmitting electric energy at a high voltage—and a low current—reduces line losses.

13. **Note:** In the text, 5.7 kJ should be 57 kJ. Otherwise, this incandescent bulb will be 90% efficient.

    Given

    $P = 100\ W$

    $t = 10\ min = 600\ s$

    Waste energy output $= 57\ kJ = 57\ 000\ J$

    Required

    The efficiency of the incandescent bulb

    Analysis

    Use the expression $E = Pt$ to find energy input in joules.

    Use $1\ W = 1\ J/s$

    Then, use the following expression to find efficiency.

    $$\text{Efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100\%$$

Solution

$$E = Pt$$

$$= 100\ \frac{\text{J}}{\text{s}} \times 600\ \text{s}$$

$$= 60\ 000\ \text{J}$$

$$= 60\ \text{kJ}$$

useful energy output = energy input – waste energy output

$$\text{Efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100\%$$

$$= \frac{(60\ \text{kJ} - 57\ \text{kJ})}{60\ \text{kJ}} \times 100\%$$

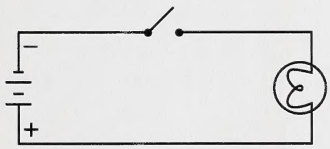
$$= 5.0\%$$

Paraphrase

The incandescent bulb is 5.0% efficient.

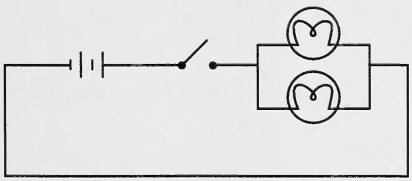
16. The student should draw a diagram similar to the following one.

Circuit Diagram



28. Diagrams should look like the following.

Circuit Diagram



32. A—These terminals connect the power source to the motor. The insulation separating the terminals may not be visible.

B—The split-ring commutator connects the coil to the brushes and acts as a switch to turn the electromagnet on and off and to alternate the polarity of the electromagnet.

C—Permanent magnets, also referred to as field magnets, simultaneously repel and attract the armature poles.

D—Brushes are a sliding connection between the rotating commutator and the stationary external circuit.

E—Coil around an iron core becomes an electromagnet when current flows through the coil. Its poles are simultaneously attracted and repelled by the permanent magnets as its polarity changes—this causes the armature to spin.

36. Given

$I = 12\ \text{A}$

$V = 120\ \text{V}$

$t = 10\ \text{min}$

$= 600\ \text{s}$

Required

Power rating of the vacuum cleaner in watts

Energy consumption in joules

Analysis

Use the expressions $P = IV$ and $E = Pt$.

Use $1\ \text{W} = 1\ \text{J/s}$ to convert watts into joules.

Solution

$P = IV$

$= 12\ \text{A} \times 120\ \text{V}$

$= 1440\ \text{W}$

$E = Pt$

$= 1440\ \frac{\text{J}}{\text{s}} \times 600\ \text{s}$

$= 86\ 400\ \text{J}$

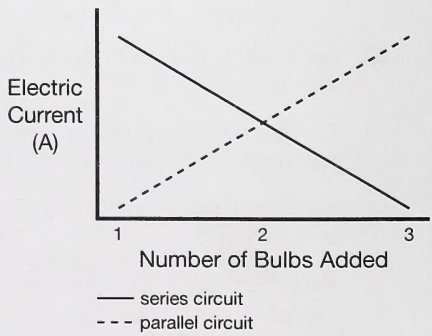
$= 86.4\ \text{kJ}$

Paraphrase

The vacuum cleaner has a power rating of 1440 W and consumes 86.4 kJ of energy in 10 minutes.

38. For a constant voltage, the following relationships hold: When more bulbs are added in parallel to a circuit the current increases, whereas when bulbs are added in series the current decreases.

The following is a sketched graph representing the relationships.



ASSIGNMENT BOOKLET 4B

Science 9
Module 4: Section 3 Assignment and Final Module Assignment

Home Instructor's and Student's Comments:

STUDENT FILE NUMBER
(if label is missing or incorrect)

_____

Date Submitted:

_____

Apply Module Label Here

Name _____

Address _____

_____

_____

Postal Code _____

Please verify that preprinted label is for correct course and module.

FOR SCHOOL USE ONLY

Assigned Teacher:

_____

Date Assignment Received:

_____

Grading:

_____

Teacher's Comments

_____

Teacher's Signature

Home Instructor: Keep this sheet when it is returned to you as a record of the student's progress.

INSTRUCTIONS FOR SUBMITTING THIS DISTANCE LEARNING ASSIGNMENT BOOKLET

When you are registered for distance learning courses, you are expected to regularly submit completed assignments for correction. Try to submit each Assignment Booklet as soon as you complete it. Do not submit more than one Assignment Booklet in one subject at the same time. Before submitting your Assignment Booklet, please check the following:

- Are all the assignments completed? If not, explain why.
- Has your work been reread to ensure accuracy in spelling and details?
- Is the booklet cover filled out and the correct module label attached?

MAILING

1. Do **not** enclose letters with your Assignment Booklets. **Send all letters in a separate envelope.**

2. Put your Assignment Booklet in an envelope and take it to the post office and have it weighed. Attach **sufficient postage** and seal the envelope.

FAXING

1. Assignment Booklets may be faxed to the school with which you are registered. Contact your teacher for the appropriate fax number.

2. All faxing costs are the responsibility of the sender.

E-MAILING

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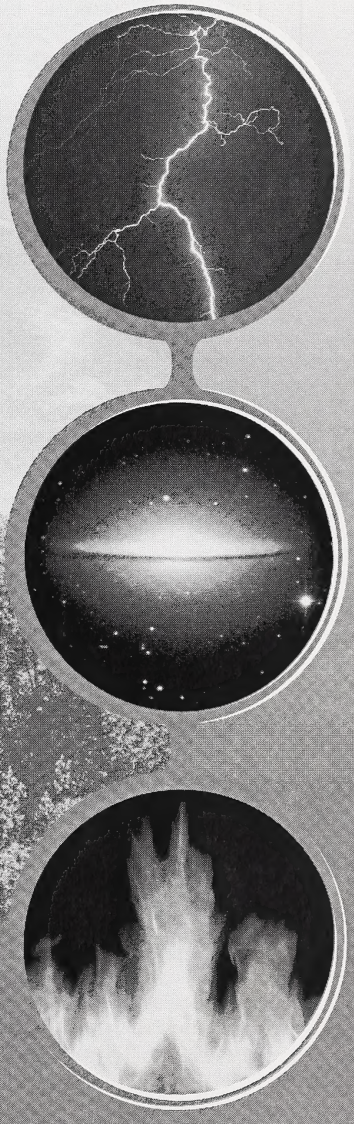
SCIENCE 9

Module 4

Electrical Principles and Technologies

Assignment Booklet 4B



Learning Technologies Branch

Alberta LEARNING

FOR TEACHER'S USE ONLY

Summary

	Total Possible Marks	Your Mark
Section 3 Assignment	33	
Final Module Assignment	49	
	82	

Teacher's Comments

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Module 4: Electrical Principles and Technologies
Assignment Booklet 4B
Section 3 Assignment and Final Module Assignment
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ASSIGNMENT BOOKLET 4B
SCIENCE 9: MODULE 4
SECTION 3 ASSIGNMENT AND FINAL MODULE ASSIGNMENT

Your mark for this module will be determined by how well you do your assignments.

This Assignment Booklet is worth 82 marks out of the total 155 marks for the assignments in Module 4. The value of each assignment and each question is stated in the left margin.

Work slowly and carefully. If you have difficulty, go back and review the appropriate topic.

Be sure to proofread your answers carefully.

Section 3 Assignment: Electricity Production, Distribution, and Use

(33)

Read all parts of your assignment carefully and record your answers in the appropriate places.

(3) **1.** Three conditions must be met before a magnet can produce an electric current in a material. List these three conditions.

_____

_____

_____

(2) **2.** Use your knowledge of electric charges and magnets, and list two similarities between electricity and magnetism.

_____

_____

_____

_____

(1) **3.** **a.** Explain what happens to the magnetic field when the current through a wire coil is reversed.

_____

_____

(2) **b.** How is this applied in a simple DC motor?

_____

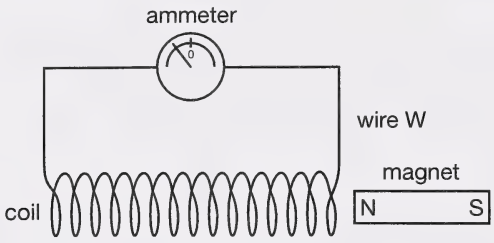
_____

_____

_____

_____

(3) **4.** Use the following diagram to answer the question.



When the bar magnet in the diagram moves toward the coil, the ammeter needle deflects to the right of the zero in the scale's centre. Describe what happens when the magnet stops moving, and then when the magnet moves to the right. Explain your answers.

_____

_____

_____

_____

Return to page 54 of the Student Module Booklet and continue with Lesson 2.

5. In Canada, a certain household appliance uses a 2.5 A current.

(3) **a.** Determine how much power the appliance needs to operate. (**Hint:** Remember that the household voltage in North America is 120 V.) Show your work.

(3) **b.** Determine how much electricity will be consumed if the appliance is used for 5 h each day over a 30-day period. Show your work.

6. The identification plate on a microwave oven states that at 120 V its power rating is 1320 W, and its normal maximum output power is 1200 W.

(3) **a.** Calculate the efficiency of this microwave oven. Show your work.

(3) **b.** Assume the cost of electrical energy is \$0.089/kW • h. Calculate the cost of heating a meal in this microwave oven for 2.0 minutes. Show your work.

(1)

7. Circle the letter of the best response.

Which of the following power sources would be the most dangerous?

A. 6 A, 10 V
B. 5 mA, 15 V
C. 7 A, 120 mV
D. 100 mA, 120 mV

Return to page 63 of the Student Module Booklet and continue with Lesson 3.

(2)

8. a. The nuclear reactions—fission and fusion—are tremendous sources of energy. List the major difference and a similarity between the two processes.

Difference

_____

_____

Similarity

_____

_____

(2)

b. List a disadvantage for using each of these reactions as an energy source in electrical energy generation.

Fission

_____

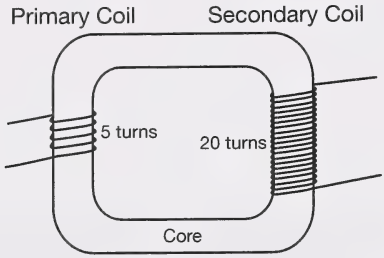
_____

Fusion

_____

_____

9. Refer to the following diagram to complete the question.



(1) **a.** What kind of transformer is shown in the diagram?

_____

(1) **b.** Where might such a device be used and for what purpose?

_____

_____

(3) **10.** You feel it is important to do your part in conserving energy and non-renewable resources. You are aware that electrical generation has negative impacts on the environment. List three ways in which you, your family, and/or your community could use or produce electrical energy more responsibly.

a. _____

_____

b. _____

_____

c. _____

_____

Return to page 69 of the Student Module Booklet and continue with the Module Summary.

49

Final Module Assignment

Read all parts of your assignment carefully and record your answers in the appropriate places.

2

1. How does adding loads into a series circuit affect its resistance? Explain.

_____

_____

_____

_____

4

2. Draw a circuit diagram for a household circuit that contains

- two lights controlled by a single switch
- four plug-ins that have constant power
- a closet light that can be turned on or off independently

Use the symbol 

for the plug-ins.

3. Refer to the circuit diagram in question 20 on page 350 of the textbook.

a. How many batteries are in the circuit?

_____

1

(1) **b.** Are the electrons flowing clockwise or counterclockwise? Why?

_____

_____

(1) **c.** Which bulb(s) would be on in this circuit?

_____

(1) **d.** Which bulb(s) would be on if bulb C burned out and switch F were closed?

_____

(6) **4.** Suppose you want to connect the speakers in your room to the stereo downstairs. Think about the choices you should make to ensure a safe installation and the strongest possible signal. List three appropriate choices. For each choice, explain why you made the choice.

- _____

  _____

- _____

  _____

- _____

  _____

5. Explain the function of each of the following wet cell components.

(2) **a.** negative electrode

_____

_____

(2) **b.** positive electrode

_____

_____

(1) **c.** electrolyte

_____

6. A single fully charged lead-acid cell delivers 2 V.

(1) **a.** How many cells are required to build a 12 V car battery?

_____

(2) **b.** How should the cells be connected? Why?

_____

_____

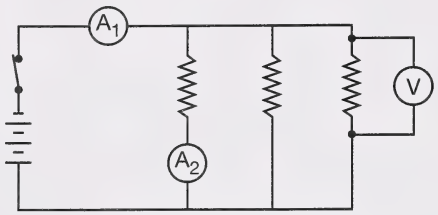
(2) **7.** Some TV picture tubes require an operating voltage of 20 000 V (20 kV). How could this be achieved when the television set is plugged into a 120 V outlet? Be specific.

_____

_____

(3) **8.** A simple circuit consists of a battery, a switch, and a 9.0 Ω resistor in series. The battery uses three 1.5 V cells connected in parallel. Determine the current that flows through this circuit when the switch is closed. Show your work.

9. Refer to the following diagram to answer the questions.



The resistors in this circuit each have a resistance of 5.0 Ω. The battery supplies a voltage of 4.5 V to the circuit.

(3) **a.** Determine the reading on the voltmeter. Use your knowledge of circuit voltage to explain your reasoning.

(3) **b.** Determine the reading on meter A_2. Show your work.

(3)

c. Determine the reading on meter A_1. Use your knowledge of circuits to give your reasoning. Be specific.

_____

_____

_____

_____

_____

(9)

10. Identify the following energy converters by filling in the answer blanks after each description.

a. two strips of metal used to convert heat into electricity _____

b. two strips of metal in a paste used to convert chemical energy into electrical energy

_____

c. converts light into electrical energy _____

d. a crystal with electrons that vibrate converting sound or kinetic energy into electrical energy _____

e. converts electrical into magnetic "energy" (The energy is stored in the field around a magnet.) _____

f. opposes the flow of electrons to convert electrical energy into thermal energy

_____

g. converts chemical energy into thermal energy into electrical energy with no moving parts

_____

h. converts electrical energy into mechanical energy using an electromagnet

_____

i. converts mechanical energy into electricity _____

(1) **11. a.** When you use a rheostat, where does the lost energy go? Be specific.

_____

_____

(1) **b.** Why might this be a problem?

_____

_____

Submit your completed Assignment Booklet 4B to your teacher for assessment.

ASSIGNMENT BOOKLET DECLARATIONS

The school you are registered with may require you to submit this signed form with your Assignment Booklet.

The Student's Declaration is to be signed by the student. If the student is under 16, the Supervisor's Declaration may need to be signed by the supervisor, who is usually a home instructor, teacher, or home-schooling coordinator. Failure to complete this page may invalidate the assignment results. Please contact your school and ask if this completed form is required.

STUDENT'S DECLARATION

- I have followed the instructions outlined in the Student Module Booklet.
- I have completed the activities to prepare myself for the assignments in this Assignment Booklet.
- I completed the assignments in this Assignment Booklet by myself.

_____

Student's Signature

SUPERVISOR'S DECLARATION

I hereby certify that I have supervised the learning activities completed by _____.

Student's Name

I also certify that to the best of my knowledge the assignments in this Assignment Booklet were completed independently by this student.

_____

Supervisor's Signature

If you, the student or supervisor, have any comments or observations regarding this module, write them in the following space.

_____

_____

_____

_____

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